

## **Title: What's Slope Got to Do with It?**

### **Brief Overview:**

This learning unit provides students with a variety of opportunities to examine slope and y-intercept in real-world situations. Students will gain a conceptual understanding of slope and y-intercept, as well as be able to see the connections between the equation, graph, and table. Students will also use information provided in word problems to write linear equations, as well as utilize data from tables to determine a line of best fit. Lastly, students will make predictions in order to solve problem-based situations.

### **NCTM 2000 Principles for School Mathematics:**

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

### **Links to NCTM 2000 Standards:**

- **Content Standards**

#### **Number and Operations**

Students will work flexibly with fractions, decimals, and percents to solve problems. Students will understand the meaning and effects of arithmetic operations with fractions, decimals, and integers.

#### **Algebra**

Students will explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope. Students will use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships. Students will model and solve contextualized problems using various representations, such as graphs, tables, and equations.

### **Data Analysis and Probability**

Students will make conjectures about possible relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit. Students will discuss and understand the correspondence between data sets and their graphical representations, especially histograms, stem-and-leaf plots, box plots, and scatter plots.

#### **• Process Standards**

### **Problem Solving**

Students will solve problems that arise in mathematics and in other contexts. Students will apply and adapt a variety of appropriate strategies to solve problems.

### **Reasoning and Proof**

Students will select and use various types of reasoning and methods of proof.

### **Communication**

Students will organize and consolidate their mathematical thinking through communication. Students will communicate their mathematical thinking coherently and clearly to peers, teachers, and others. Students will use the language of mathematics to express mathematical ideas precisely.

### **Connections**

Students will recognize and use connections among mathematical ideas. Students will understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

### **Representation**

Students will select, apply, and translate among mathematical representations to solve problems. Students will use representations to model and interpret physical, social, and mathematical phenomena.

#### **Links to Maryland Core Learning Goals:**

### **Functions and Algebra**

#### **• 1.1.2**

The student will represent patterns and/or functional relationships in a table, as a graph, and/or by mathematical expression.

#### **• 1.2.1**

The student will determine the equation for a line, solve linear equations, and/or describe the solutions using numbers, symbols, and/or graphs.

#### **• 1.2.3**

The student will solve and describe using numbers, symbols, and/or graphs if and where two straight lines intersect.

## **Data Analysis and Probability**

### **• 3.2.2**

The student will interpret data and/or make predictions by finding and using a line of best fit and by using a curve of best fit.

#### **Grade/Level:**

Grades 7, 8, and 9, Algebra I

#### **Duration/Length:**

Five class periods

#### **Prerequisite Knowledge:**

Students should have working knowledge of the following skills:

- Identifying the slope and y-intercept given a graph, equation, or a table
- Graphing a linear equation on the TI-83
- Writing a linear equation in slope-intercept form
- Calculating a line of best fit given a set of data

#### **Student Outcomes:**

Students will:

- describe the effect of changing the slope or y-intercept on a graph.
- interpret slope as a rate of change and the y-intercept as a constant.
- determine the linear equation given a graph, table, or a situation.
- graph a line in the coordinate system and on the graphing calculator.
- approximate the line of best fit and use it to interpret data or to make predictions.
- use the relationship between the equation, slope, and the y-intercept of a line in order to solve problems.

#### **Materials/Resources/Printed Materials:**

- TI-83 graphing calculator
- Ruler

#### **Development/Procedures:**

##### **Day One: Reviewing Slope and Intercept**

- Materials - Graphing calculators
- Students are given Activity One: Investigating Linear Relations.
- Students will work in pairs to complete this activity.
- Teacher calls upon selected groups to go to the overhead to explain their answers.
- Homework: Sketch the graphs and write the equations of four linear functions. One should have a negative slope, one a positive slope, one a negative y-intercept and one a positive y-intercept.

**Days Two and Three: Real-World Linears**

- Materials - Graphing calculators and graphing calculator directions
- Students are given Activity Two: Investigating Slope and Y-Intercept in the Real World.
- Students are to complete A: A Day at the Fair as a large group with class discussion.
- Students are to complete parts B: Canoe Adventure and C: Sweet Sixteen in small groups of three to four.
- Students are to complete Part D: Can We Talk separated for individual work.
- Written work is to be assessed according to the attached MD High School Assessment Rubric for Brief Constructed Responses.

**Days Four and Five: Performance Assessment**

The students will apply their knowledge of slope and y-intercept in a problem-based situation in order to make a reasonable decision. The students will be presented with two summer jobs and they will be asked to choose which job is more profitable for them based upon information gathered from the graph, equation, and table.

- Materials - Graphing calculators
- Students are given Activity Three: Summer Jobs.
- Students will complete Part One: Bussing Tables in small groups of three to four.
- Students are to complete Part Two: Mowing lawns separated for individual work.
- Written work is to be assessed according to the attached MD High School Assessment Rubric for Extended Constructed Responses.

**Extension/Follow Up:**

Students can conduct an experiment in which they examine the relationship between the slope and y-intercept in one of the following linear relationships: the circumference and diameter of circular objects, a human's arm span and height, the temperature and time of day, or a basketball's drop height and rebound height.

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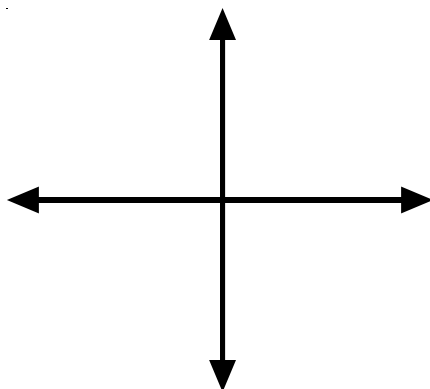
## Activity One: Graphing Linear Relations

Objective:

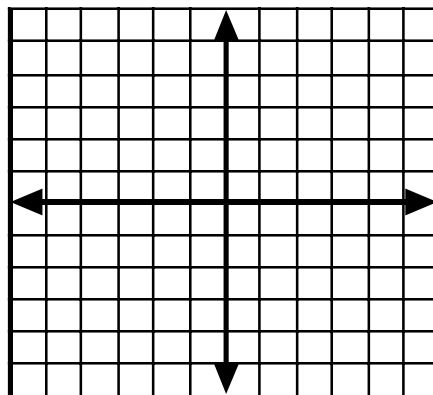
- To review the relationships between the coefficient of  $x$  in a linear equation and the position of a line.
- To review the relationship between the constant in a linear equation and the location of a line.

I. Make sure your window (TI-83) is set to the defaults  $(-10, 10, 1)$  for both  $x$  and  $y$ . Graph the following linear equations. Sketch the results below:

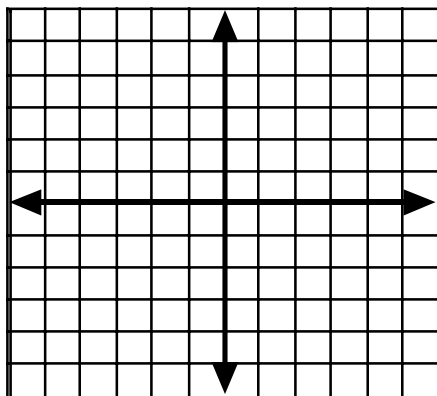
a)  $y = 3x + 5$



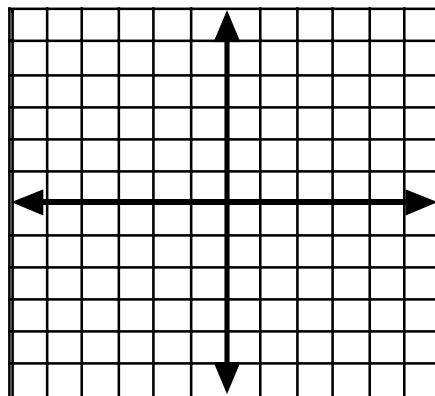
b)  $y = -4x - 3$



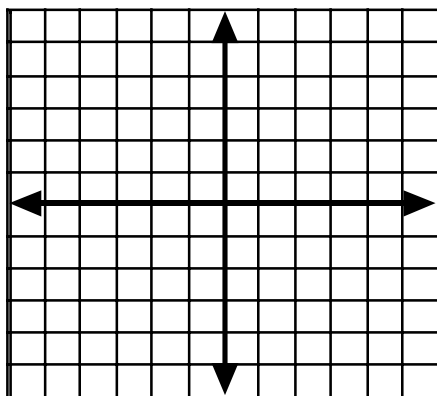
c)  $y = 2x - 4$



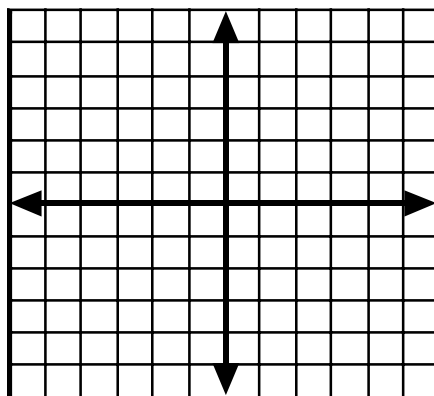
d)  $y = -x - 1$



e)  $y = .5x + 6$

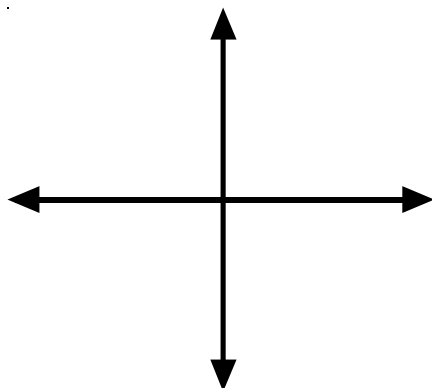


f)  $y = -3x + 5$



1. What is the relationship between the coefficients of  $x$  and the way the lines appear on your screen?

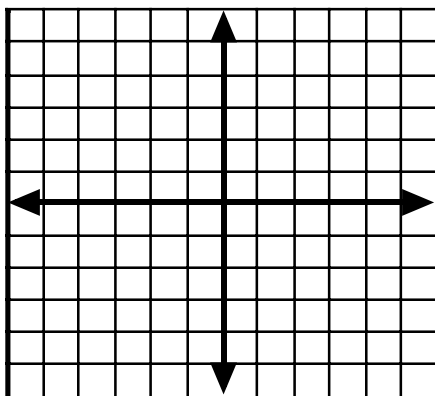
2. Sketch two equations that model this relationship on the grid below. Be sure to label each line with its equation.



II. Observe the same six lines again.

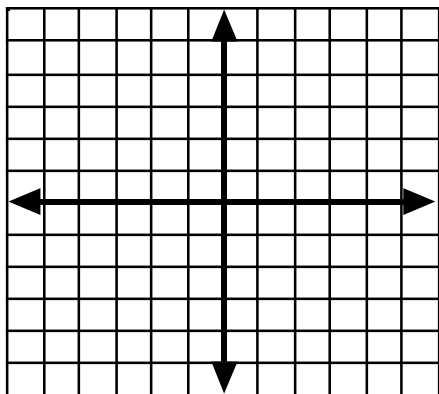
3. What is the relationship between the constants and the way the lines appear on your screen?

4. Sketch two equations that model this relationship on the grid below. Be sure to label each line with its equation.

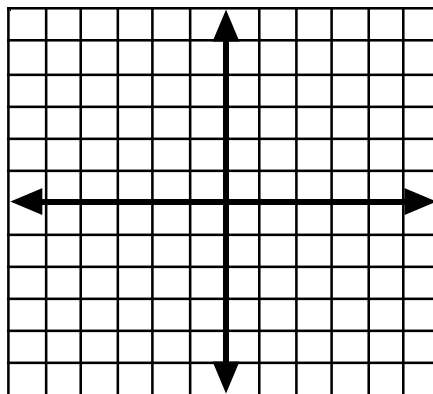


III. Graph the following four lines (in order from a-d). Sketch the results below:

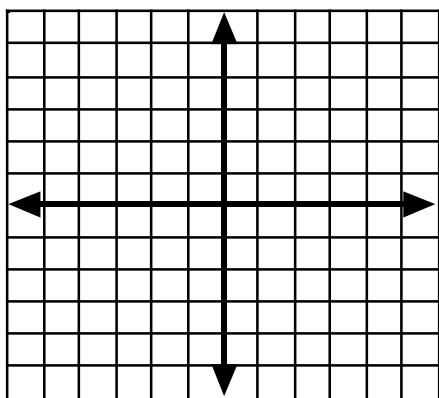
a)  $y = .5x + 2$



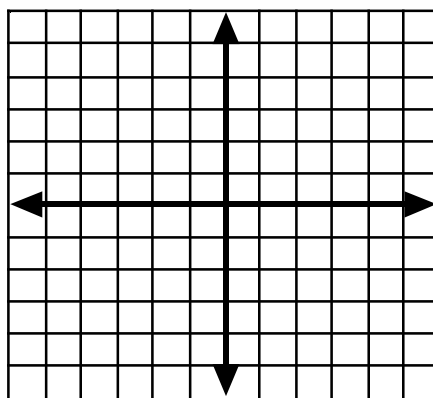
b)  $y = x + 2$



c)  $y = 1.5x + 2$



d)  $y = 2x + 2$



5. Use mathematics to explain what happens to the position of the line as a result of the changes in slope and y-intercept. Use words, symbols, or both in your explanation.

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6. Summarize in a table the three relationships between the equation of a line and its slope and y-intercept.

## Activity Two: Investigating Slope and Y-Intercept in the Real World

**Directions:** Use what you have learned about the concepts of slope and y-intercept to solve:

### A. A Day at the Fair

You and your friends plan to attend the annual county fair this weekend. The entry fee for the carnival is \$5.00 and the cost per ticket is \$0.50.

| Number of Tickets | Cost    |
|-------------------|---------|
| 8                 | \$9.00  |
| 12                | \$11.00 |
|                   | \$12.50 |
| 23                |         |

1. Complete the above table.
2. Write a linear equation in which  $y$  represents the total cost and  $x$  represents the number of rides selected.
3. Identify the slope and y-intercept in the equation and explain what each of them represents in the context of the problem.

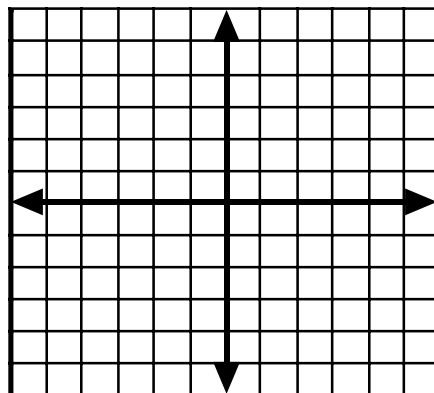
slope ( $m$ ) =

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y-intercept ( $b$ ) =

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- 4.) Sketch the graph of the linear equation.





5. Your parents have decided to give you \$20.00 to spend at the fair. If you need three tickets for each ride, how many rides will you be able to go on? Use mathematics to explain your answer. Use words, symbols, or both.

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### **B. Canoe Caper**

While your family is visiting Deep Creek Lake, you and your brother decide to go boating. The park rangers require a \$25.00 deposit to rent a canoe and a rental fee of \$6.50 per hour.

1. Write a linear equation in which  $y$  represents the total cost of renting a canoe and  $x$  represents the number of hours spent on the canoe. \_\_\_\_\_
2. Identify the slope and  $y$ -intercept in the equation and explain what each of them represents within the context of the problem.

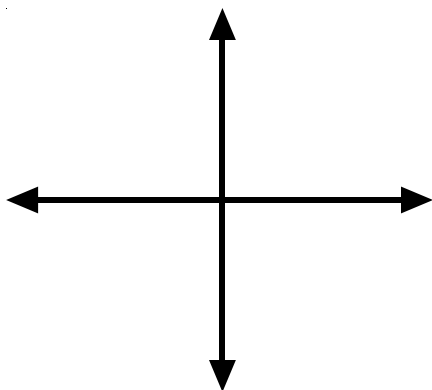
slope ( $m$ ) =

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$y$ -intercept ( $b$ ) =

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3. Using your TI-83, graph the linear equation. Sketch it below.



4. Using the trace or table function on the TI-83, find the cost of renting a canoe from 12:30 to 3:30 PM provided that the canoe is returned in the same condition in which you received it.

Cost:

Use mathematics to explain how you got your answer. Use words, symbols, or both.

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### C. Sweet Sixteen

Your parents have decided to buy a new Toyota 4Runner for \$25,635 and they have promised that the SUV will be yours when the car is worth \$10,000. According to the car dealer, your parents' SUV will depreciate in value approximately \$3,000 per year.

1. Write a linear equation in which  $y$  represents the total value of the car and  $x$  represents the age of the car.
2. Identify the slope and  $y$ -intercept in the equation and explain what each of them represents within the context of the problem.

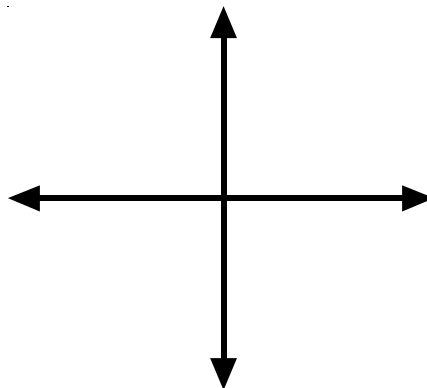
$m =$

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$b =$

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3. Using your TI-83, graph the linear equation. Sketch the line below.



4. a. Based on the information above, will the Toyota 4Runner be yours on your sixteenth birthday?
- b. If not, how old you will be when the SUV is finally yours?
- c. Explain your answer by using mathematics. Use words, symbols, or both.

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**D. Can We Talk?**

You have just signed an annual contract with Verizon for a cellular phone. The base rate is \$32 per month for 200 minutes and \$0.14 per minute for all additional minutes.

1. Write a system of linear equations in which  $y$  represents the total cost for the cell phone per month and  $x$  represents the number of minutes spent on the phone each month.

First 200 minutes:

More than 200 minutes:

2. Identify the slope and  $y$ -intercept in the linear equation which represents the cost of the cellular phone when using more than 200 minutes in a given month. Then, explain what the slope and  $y$ -intercept represent within the context of the problem.

$m =$

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$b =$

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3. Examine the linear equation which represents the cost of the cellular phone when using fewer than 200 minutes. Why is this linear equation different from the other equation? Justify your answer by using mathematics. Use words, symbols or both.

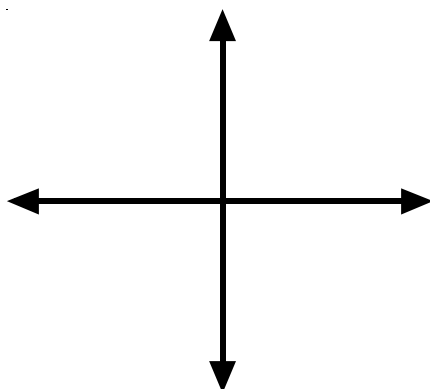
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4. Graph the two linear equations in your TI-83 and sketch the results on the coordinate grid.



5. Your cell phone bill for last month was \$629.40 and you know that this cost is much too high. If you talked on your cellular phone for 221 minutes last month, how much do you believe your bill should have been? Explain your answer using mathematics. Use words, symbols, or both.

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## Student Resource Sheet for Scatter Plots & Regression Lines on the TI-83

### Graphing the Scatter Plot:

- I. Go to the STAT menu to #1 Edit and push ENTER.
- II. If there is already information in any of the lists, go to the top of the list so your cursor is on the list's name (example L1).

Push CLEAR and push ENTER. Your list will clear.

- III. Type in your data. Normally you would use L1 for your x data and L2 for your y data. Push ENTER or use the down arrow after each entry.
- IV. Set your window: push WINDOW. Set your x minimum and maximum and your y minimum and maximum and your x and y scales (the distance between tic marks on the axis) to reflect the data you have. For example, if your x data ranges from 5 to 99, you might choose an x min of 0, max of 100 and scale of 5.
- V. Make sure there are no linear equations in the Y= menu (push CLEAR if there are). Push GRAPH. If it doesn't look right, try checking your WINDOW settings.

### Getting the Regression Line:

Method One:

- A. Push STAT. Push the right arrow to get the CALC menu. Push #4 to get the LinReg function.
- B. To get your slope and y-intercept. (Instead of  $y=mx + b$ , this calculator uses  $y=ax + b$ .) Push 2nd L1. Push the comma key. Push 2nd L2. Push ENTER. This will give you the numbers for a & b. Write them down.
- C. Push the Y= key. Enter your equation, using the a & b you wrote down. Push GRAPH. You should see both your scatter plot and the regression line.

Method Two:

To get your slope and y-intercept and regression line equation the quick way:

Push STAT. Push the right arrow to get the CALC menu. Push #4 to get the LinReg function. (Instead of  $y=mx + b$ , this calculator uses  $y=ax + b$ .) Push the comma key. Push VARS. Push the right arrow. Select #1 and #1 again. Push ENTER. This stores the regression line equation to the Y= menu. Push ENTER again and push GRAPH.

## Maryland High School Assessment Brief Constructed Response Rubric

### LEVEL 3

The response indicates **application** of a reasonable strategy that leads to a correct solution in the context of the problem. The **representations** are essentially correct. The **explanation** and/or **justification** is logically sound, clearly presented, fully developed, supports the solution, and does not contain significant mathematical errors. The response demonstrates a complete understanding and **analysis** of the problem.

### LEVEL 2

The response indicates **application** of a reasonable strategy that may be incomplete or undeveloped. It may or may not lead to a correct solution. The **representations** are fundamentally correct. The **explanation** and/or **justification** supports the solution and is plausible, although it may not be well developed or complete. The response demonstrates a conceptual understanding and **analysis** of the problem.

### LEVEL 1

The response indicates little or no attempt to apply a reasonable strategy or applies an inappropriate strategy. It may or may not have the correct answer. The **representations** are incomplete or missing. The **explanation** and/or **justification** reveals serious flaws in reasoning. The **explanation** and/or **justification** may be incomplete or missing. The response demonstrates a minimal understanding and **analysis** of the problem.

### LEVEL 0

The response is completely incorrect or irrelevant. There may be no response, or the response may state, "I don't know."

### Activity Three: Summer Jobs

You are searching for the perfect summer job, because your best friend has invited you to go along on a cruise in August IF you can come up with the airfare to Florida and some spending money for the trip. You have figured out that you can do it if you can save up at least \$1500 over the summer. When you check the want ads, you see that a local restaurant is advertising for busboys. This sounds like pretty hard work, so you call a friend of yours for advice. He tells you that he mowed his neighbor's lawns the previous summer and made \$1800. Instead of making a snap decision, you decide to take the time to figure out which job is likely to get you the most money.

#### I. Bussing tables

Another friend bussed tables last summer. She gives you the following information based on a fairly typical day at her job:

| Hours Worked | Wages & Tips |
|--------------|--------------|
| 1            | \$12.75      |
| 3            | \$38.25      |
| 5            | \$63.75      |
| 7            | \$95.50      |

- Using the table, write the equation for a line of best fit that will help you figure out how much money you are likely to make this summer bussing tables.
- What does the slope of this equation tell you about the job?
- Explain why the  $y$ -intercept is negative in the equation.

## II. Mowing lawns

This still seems like hard work, so you decide to estimate what you can make mowing lawns. Your parents will let you use their riding lawn mower, but you have to pay for your own gas. You figure you can get paid at least as much as your friend made (\$1800), but you need to know what the gas is likely to cost you. Your parents tell you that the mower uses about \$1.78 worth of gas per hour.

- a. Using this information, write the linear equation that will help you figure out how much money you are likely to make this summer mowing lawns.
- b. What does the slope of this equation tell you about the job?  
(Hint: Why is it negative?????)
- c. What does the  $y$ -intercept tell you about the job?

## III. Show Me the Money!

Now you need to decide which job is going to make you more money. Use your equations to figure out after how many hours the income from both jobs will be the same.

- a. Number of hours worked:

Amount earned:

- b. Briefly explain how you know your answer is right. Use mathematics to explain how you determined your answer. Use words, symbols, or both in your explanation.
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c. By the end of the summer, which job will earn you the most money?

d. Justify your decision using mathematics. Use words, symbols, or both in your explanation.

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**Maryland High School Assessment  
Extended Constructed Response Rubric**

**LEVEL 4**

The response indicates **application** of a reasonable strategy that leads to a correct solution in the context of the problem. The **representations** are correct. The **explanation** and/or **justification** is logically sound, clearly presented, fully developed, supports the solution, and does not contain significant mathematical errors. The response demonstrates a complete understanding and **analysis** of the problem.

**LEVEL 3**

The response indicates **application** of a reasonable strategy that may or may not lead to a correct solution. The **representations** are essentially correct. The **explanation** and/or **justification** is generally well developed, feasible, and supports the solution. The response demonstrates a clear understanding and **analysis** of the problem.

**LEVEL 2**

The response indicates an incomplete **application** of a reasonable strategy that may or may not lead to a correct solution. The **representations** are fundamentally correct. The **explanation** and/or **justification** supports the solution and is plausible, although it may not be well developed or complete. The response demonstrates a conceptual understanding and **analysis** of the problem.

**LEVEL 1**

The response indicates little or no **application** of a reasonable strategy. It may or may not have the correct answer. The **representations** are incomplete or missing. The **explanation** and/or **justification** reveals serious flaws in reasoning. The **explanation** and/or **justification** may be incomplete or missing. The response demonstrates a minimal understanding and **analysis** of the problem.

**LEVEL 0**

The response is completely incorrect or irrelevant. There may be no response, or the response may state, "I don't know."

**Maryland High School Assessment  
Brief & Extended Constructed Response Rubric**

**For Both Types of Questions:**

**Explanation** refers to the student using the language of mathematics to communicate how the student arrived at the solution.

**Justification** refers to the student using mathematical principles to support the reasoning used to solve the problem or to demonstrate that the solution is correct. This could include the appropriate definitions, postulates and theorems.

**Essentially correct representations** may contain a few minor errors such as missing labels, reversed axes, or scales that are not uniform.

**Fundamentally correct representations** may contain several minor errors such as missing labels, reversed axes, or scales that are not uniform.

3/1999, edited 2/22/00, 3/7/00 and 8/16/00

